Understanding the 2020 Census Disclosure Avoidance System:

Production settings and DAS accuracy metrics for the P.L. 94-171 Redistricting Data Summary File

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Acknowledgements

This presentation includes work by the Census Bureau's 2020 Disclosure Avoidance System development team, Census Bureau colleagues, and our collaborators, from the following Census Bureau divisions and outside organizations: ADCOM, ADDC, ADRM, CED, CEDDA, CEDSCI, CES, CSRM, DCMD, DITD, ESMD, GEO, POP, TAB, CDF, Econometrica Inc., Galois, Knexus Research Corp, MITRE, NLT, TI, and Tumult Labs.

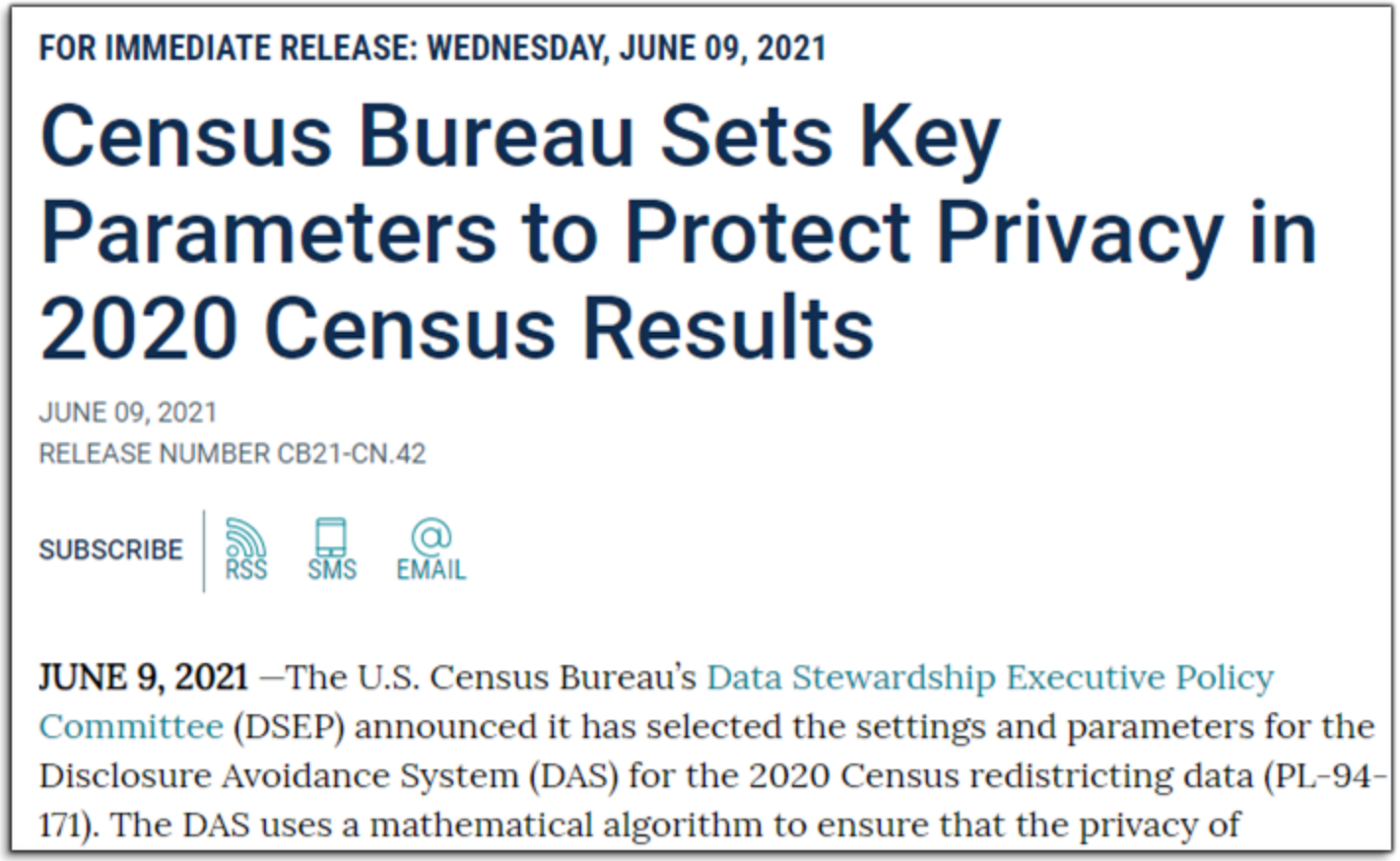
We also acknowledge and greatly appreciate the ongoing feedback we have received from external stakeholder groups that has contributed to the design and improvement of the Disclosure Avoidance System.

For more information and technical details relating to the issues discussed in these slides, please contact the author at michael.b.hawes@census.gov.

Any opinions and viewpoints expressed in this presentation are the author's own, and do not represent the opinions or viewpoints of the U.S. Census Bureau.

The statistics included in this presentation have been cleared for public dissemination by the Census Bureau's Disclosure Review Board (CBDRB-FY20-DSEP-001).

Production Settings for 2020 Census P.L 94-171 Redistricting Data Summary File



FOR IMMEDIATE RELEASE: WEDNESDAY, JUNE 09, 2021

Census Bureau Sets Key Parameters to Protect Privacy in 2020 Census Results

JUNE 09, 2021
RELEASE NUMBER CB21-CN.42

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JUNE 9, 2021 —The U.S. Census Bureau's Data Stewardship Executive Policy Committee (DSEP) announced it has selected the settings and parameters for the Disclosure Avoidance System (DAS) for the 2020 Census redistricting data (PL-94-171). The DAS uses a mathematical algorithm to ensure that the privacy of

Stakeholder Feedback

We received a substantial amount of invaluable feedback on the April 2021 Demonstration Data.

Major themes included:

- **Accuracy for AIAN tribal areas and other "off-spine" geographies**
- **Accuracy for places, Minor Civil Divisions, and tract-level data**
- **Bias (geographic and characteristic)**
- **Race and Ethnicity statistics**
- **Occupancy rates**

Key Parameters and Improvements

- **Privacy-loss Budget (PLB):**
  - **ε= 17.14 for persons**
  - **ε=2.47 for units**
- **Improvements to the optimized geographic post-processing hierarchy**
- **Extra PLB allocated to Population counts**
- **Extra PLB allocated to Race and Ethnicity statistics**
- **Extra PLB allocated to occupancy rates at the block-group level and above**

Privacy-loss Budget Allocations

https://www2.census.gov/programs-surveys/decennial/2020/program-management/data-product-planning/2010-demonstration-data-products/ProductionSettings20210608/2021-06-08-privacy-loss_budgetallocation.pdf

Privacy-loss Budget Allocations
by geographic level

April 2021 Demonstration Data:

Global rho	1.05
Global epsilon	10.3
delta	10^{-10}

	rho Allocation by Geographic Level
US	51/1024
State	153/1024
County	78/1024
Tract	51/1024
Optimized Block Group*	172/1024
Block	519/1024

Production Settings:

Global rho	**2.56**
Global epsilon	**17.14**
delta	10^{-10}

	rho Allocation by Geographic Level
US	104/4099
State	**1440/4099**
County	**447/4099**
Tract	**687/4099**
Optimized Block Group*	**1256/4099**
Block	165/4099

Privacy-loss Budget Allocations by query

April 2021 Demonstration Data:

Query	Per Query rho Allocation by Geographic Level					
	US	State	County	Tract	Optimized Block Group*	Block
TOTAL (1 cell)		678/1024**	342/1024	1/1024	572/1024	1/1024
CENRACE (63 cells)	2/1024	1/1024	1/1024	2/1024	1/1024	2/1024
HISPANIC (2 cells)	1/1024	1/1024	1/1024	1/1024	1/1024	1/1024
VOTINGAGE (2 cells)	1/1024	1/1024	1/1024	1/1024	1/1024	1/1024
HHINSTLEVELS (3 cells)	1/1024	1/1024	1/1024	1/1024	1/1024	1/1024
HHGQ (8 cells)	1/1024	1/1024	1/1024	1/1024	1/1024	1/1024
HISPANIC*CENRACE (126 cells)	5/1024	2/1024	3/1024	5/1024	3/1024	5/1024
VOTINGAGE*CENRACE (126 cells)	5/1024	2/1024	3/1024	5/1024	3/1024	5/1024
VOTINGAGE*HISPANIC (4 cells)	1/1024	1/1024	1/1024	1/1024	1/1024	1/1024
VOTINGAGE*HISPANIC*CENRACE (252 cells)	17/1024	6/1024	11/1024	17/1024	8/1024	17/1024
HHGQ*VOTINGAGE* HISPANIC*CENRACE (2,016 cells)	990/1024	330/1024	659/1024	989/1024	432/1024	989/1024

Production Settings:

Query	Per Query rho Allocation by Geographic Level					
	US	State	County	Tract	Optimized Block Group*	Block
TOTAL (1 cell)		**3773/4097****	**3126/4097**	**1567/4102**	1705/4099	5/4097
CENRACE (63 cells)	52/4097	6/4097	10/4097	4/2051	3/4099	9/4097
HISPANIC (2 cells)	26/4097	6/4097	10/4097	5/4102	3/4099	5/4097
VOTINGAGE (2 cells)	26/4097	6/4097	10/4097	5/4102	3/4099	5/4097
HHINSTLEVELS (3 cells)	26/4097	6/4097	10/4097	5/4102	3/4099	5/4097
HHGQ (8 cells)	26/4097	6/4097	10/4097	5/4102	3/4099	5/4097
HISPANIC*CENRACE (126 cells)	**130/4097**	**12/4097**	**28/4097**	**1933/4102**	**1055/4099**	21/4097
VOTINGAGE*CENRACE (126 cells)	130/4097	12/4097	28/4097	10/2051	9/4099	21/4097
VOTINGAGE*HISPANIC (4 cells)	26/4097	6/4097	10/4097	5/4102	3/4099	5/4097
VOTINGAGE*HISPANIC*CENRACE (252 cells)	26/241	2/241	101/4097	67/4102	24/4099	71/4097
HHGQ*VOTINGAGE* HISPANIC*CENRACE (2,016 cells)	189/241	230/4097	754/4097	241/2051	1288/4099	3945/4097

*The Optimized Block Groups used within the TopDown Algorithm differ from tabulation block groups. These differences improve accuracy for "off-spine" geographies like places and minor civil divisions. The use of optimized block groups for measurement and post-processing within the TopDown Algorithm does not impact how the resulting data will be tabulated. All Census data products will be tabulated using the official tabulation block groups as defined by the Census Bureau's Geography Division.

**The TOTAL query (total population) is held invariant at the state level. This rho allocation assigned to TOTAL at the state level is the amount assigned to the state-level queries for the total population of all American Indian and Alaska Native (AIAN) tribal areas within the state and for the total population of the remainder of the state, for the 36 states that include AIAN tribal areas.

Detailed Summary Metrics on Demographic Reasonableness

- Compare tabulated quantities at various geographic levels (e.g., Total Population at the county level, Asian Alone at the tract level) for a DAS run to published (i.e., swapped) 2010 tabulations.
- Metrics released for the Production Settings (June 2021) run include:

Accuracy	- Mean Absolute Error (MAE): What is the average absolute change (+/-)? - Mean Absolute Percent Error (MAPE): What is the average relative change (+/- %)
Bias	- Mean Error (ME): What is the average directional change? - Mean Algebraic Percent Error (MALPE): What is the average directional relative change?
Outliers	- How many geographies are above particular thresholds?

Calculating Metrics: MAE

County	Published 2010 Population	PPMF 2010 Population	Error	Absolute Error
Autauga County, Alabama	54,571	54,581	10	10
Baldwin County, Alabama	182,265	182,263	-2	2
Barbour County, Alabama	27,457	27,455	-2	2
Bibb County, Alabama	22,915	22,922	7	7
Blount County, Alabama	57,322	57,321	-1	1
…	…	…	…	…
Loving County, Texas	82	77	-5	5
…	…	…	…	…

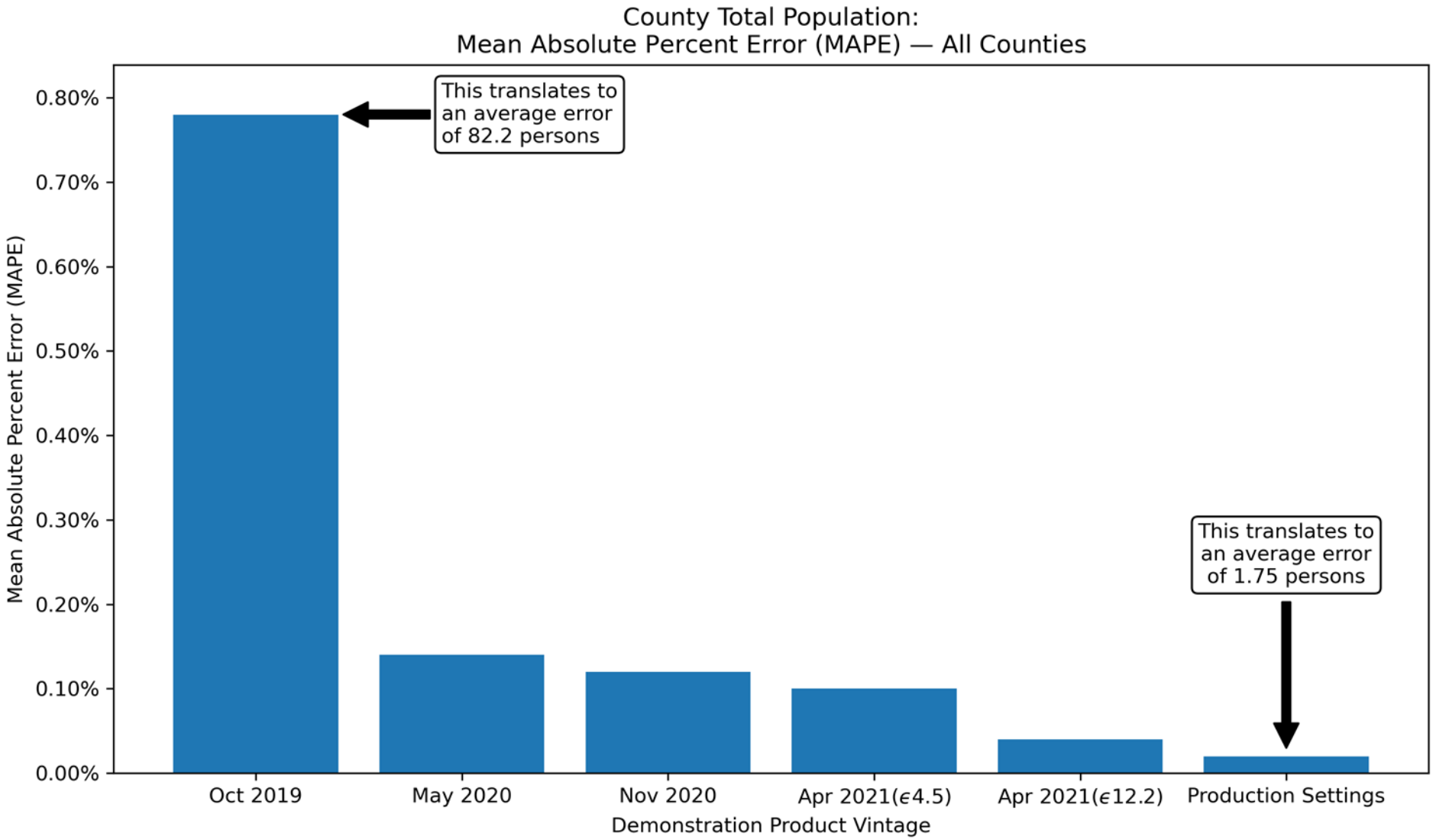
Mean Absolute Error: 4.91

Calculating Metrics: MAPE

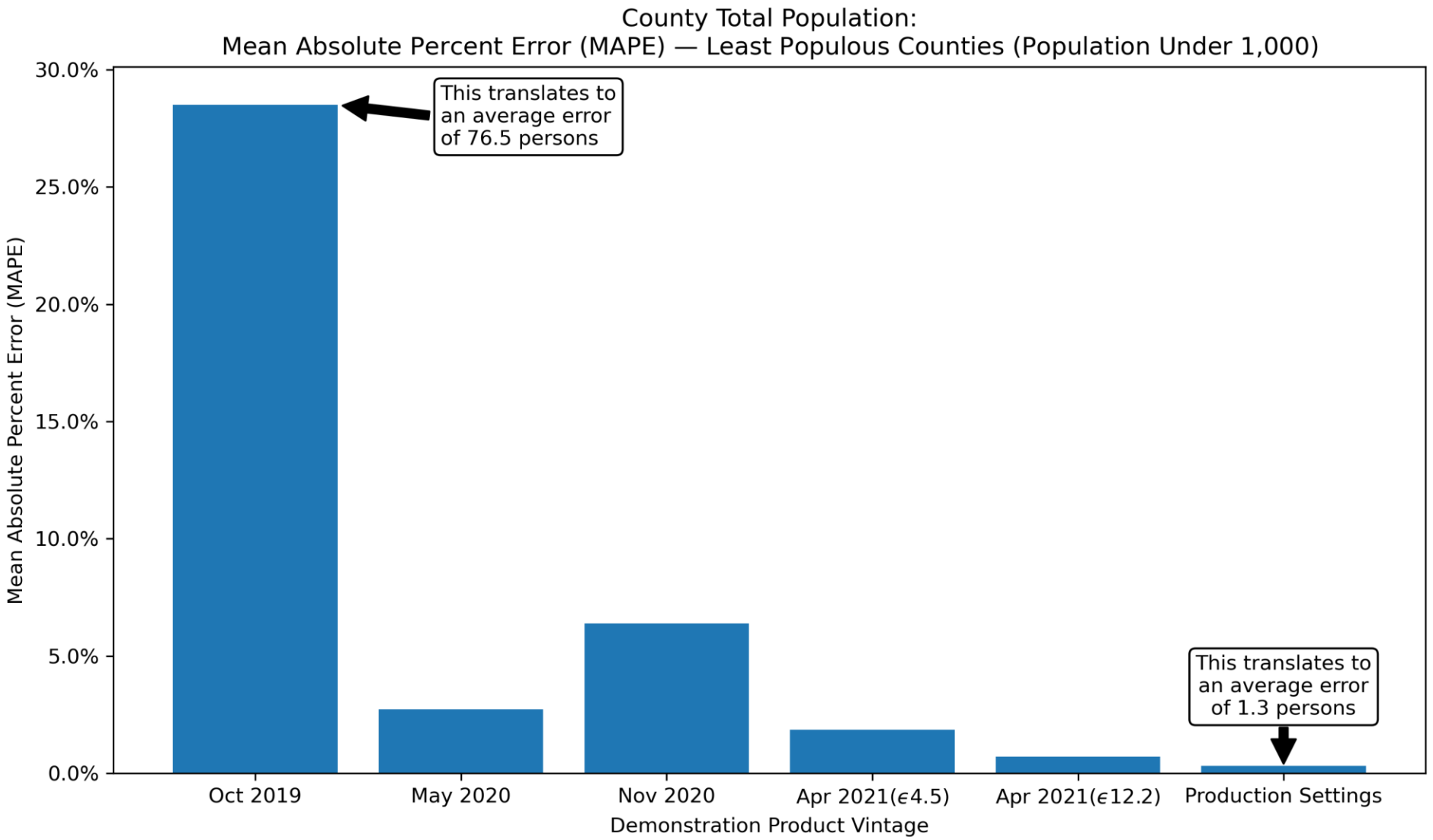
County	Published 2010 Population	PPMF 2010 Population	Percent Error	Absolute Percent Error
Autauga County, Alabama	54,571	54,581	0.0183%	0.0183%
Baldwin County, Alabama	182,265	182,263	-0.0011%	0.0011%
Barbour County, Alabama	27,457	27,455	-0.0073%	0.0073%
Bibb County, Alabama	22,915	22,922	0.0305%	0.0305%
Blount County, Alabama	57,322	57,321	-0.0017%	0.0017%
…	…	…	…	…
Loving County, Texas	82	77	-6.0976%	6.0976%
…	…	…	…	…

Mean Absolute Percent Error: 0.04%

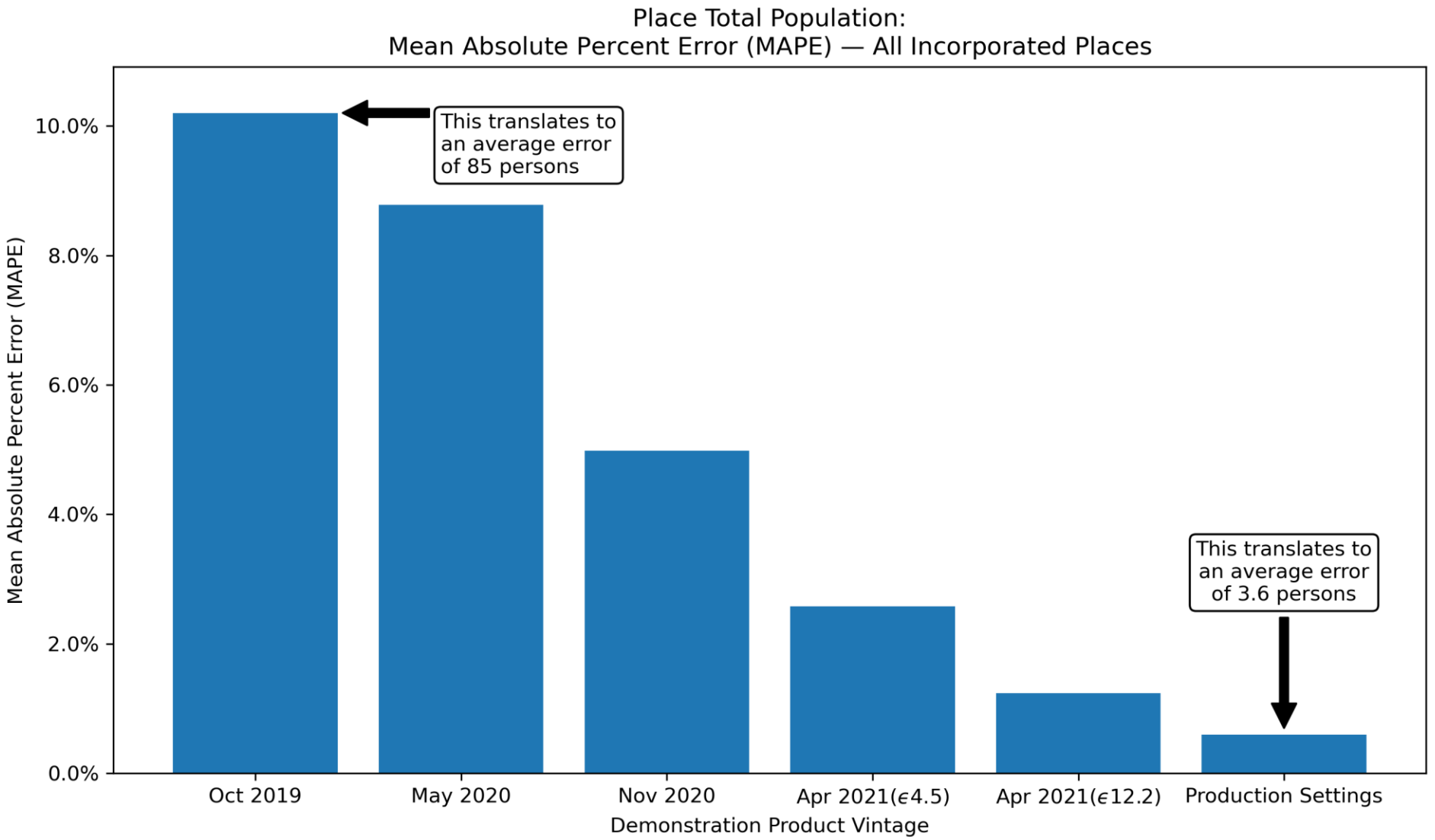
Total Population – County



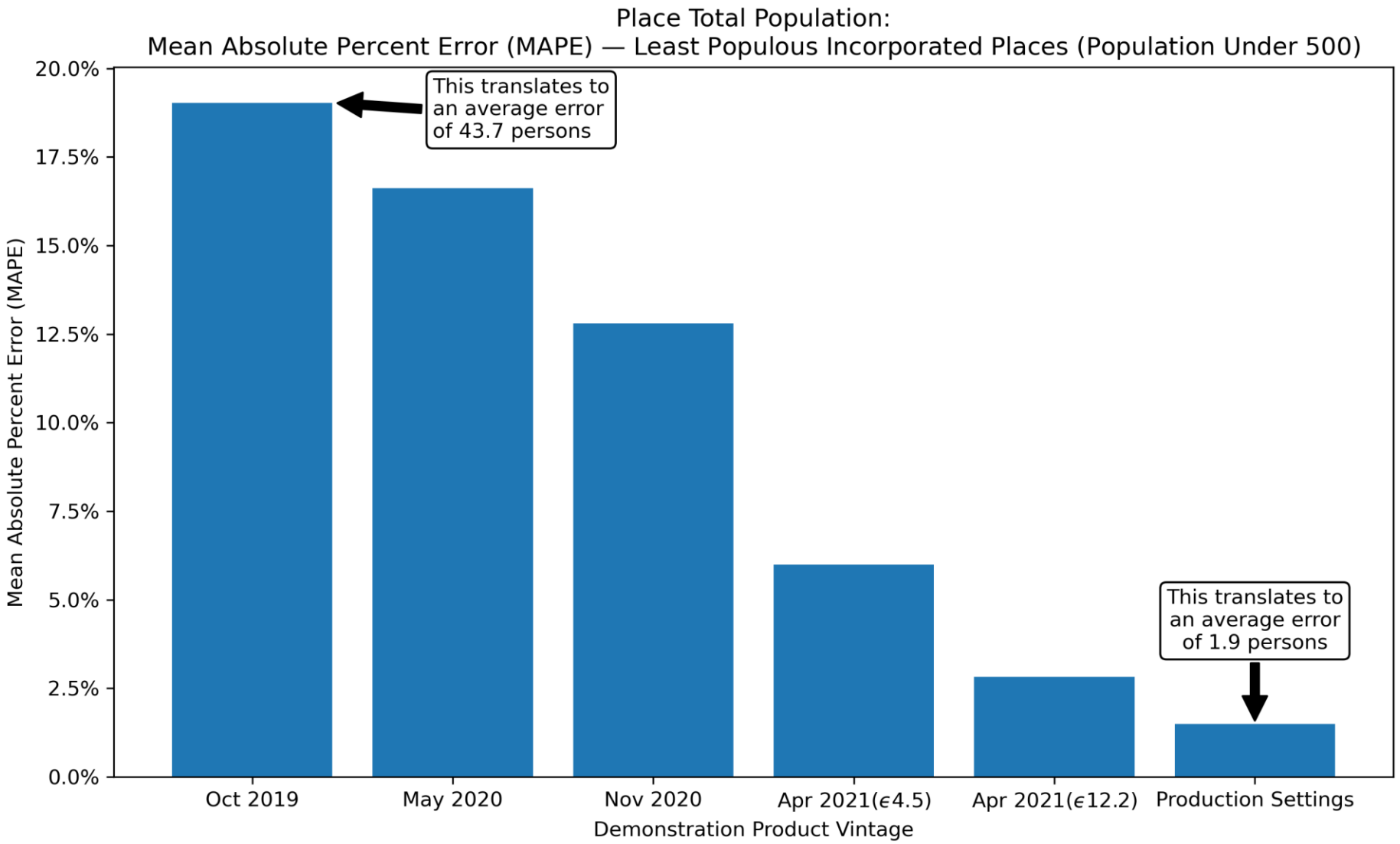
Total Population – County



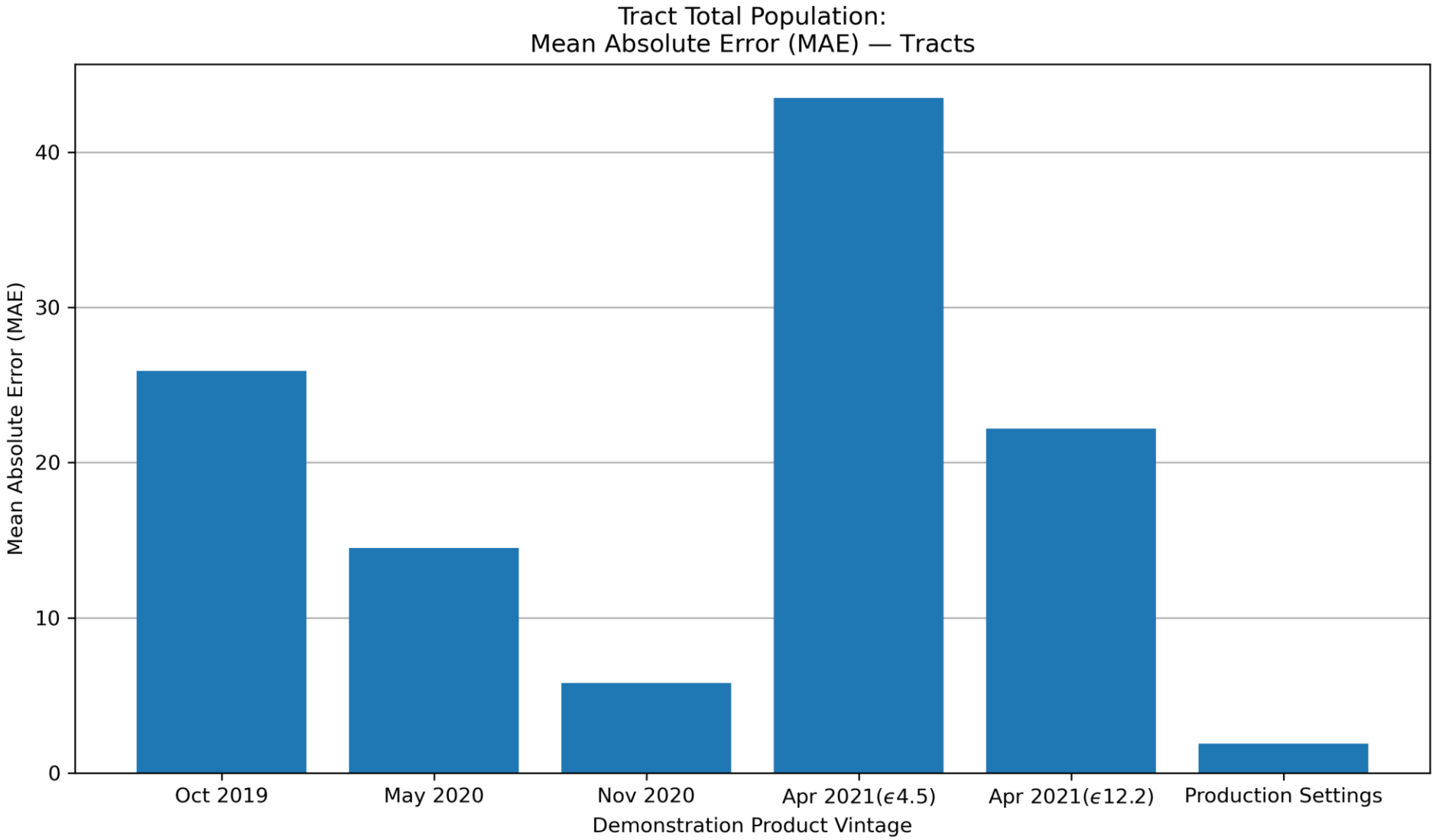
Total Population – Place



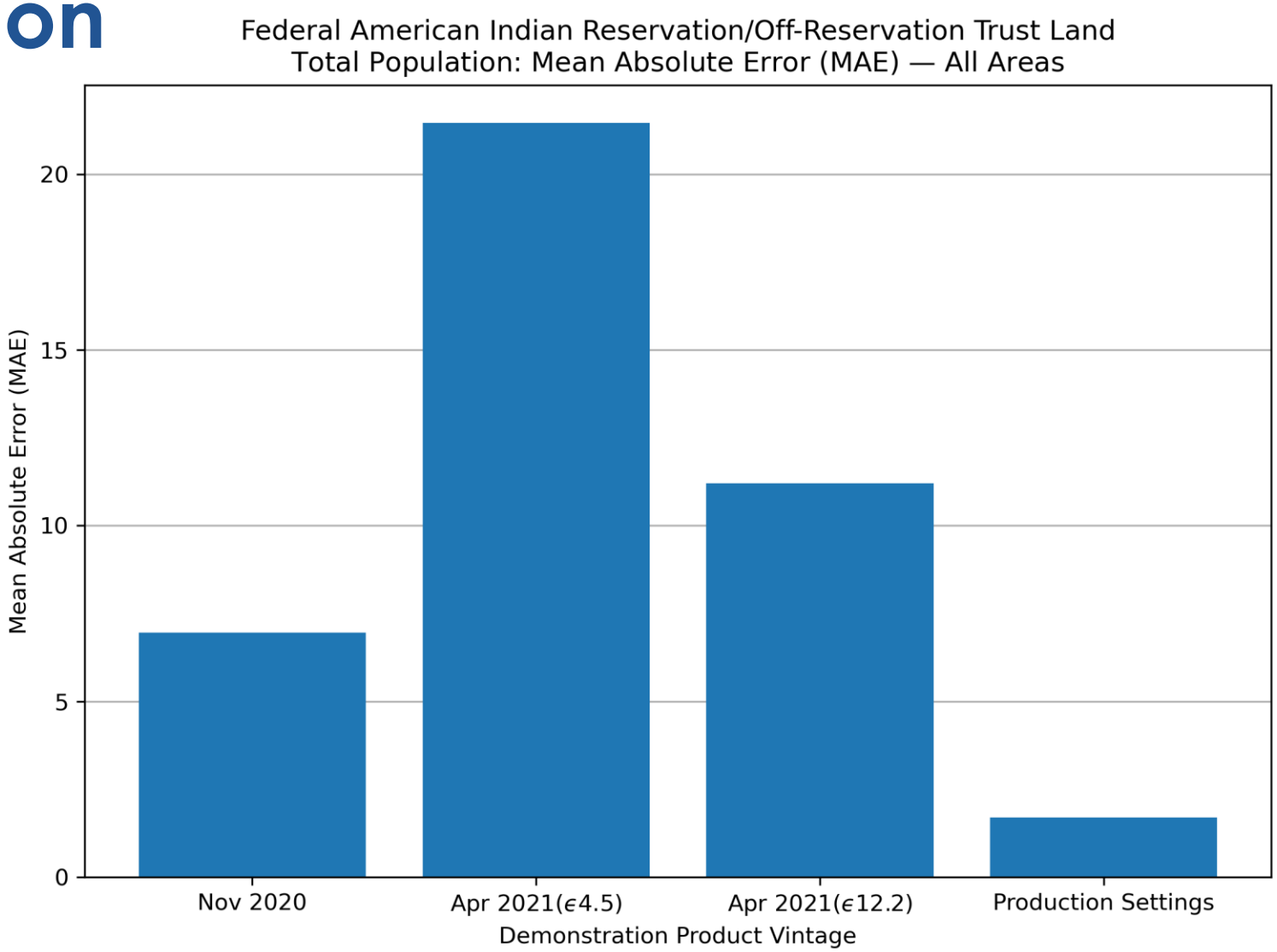
Total Population – Place



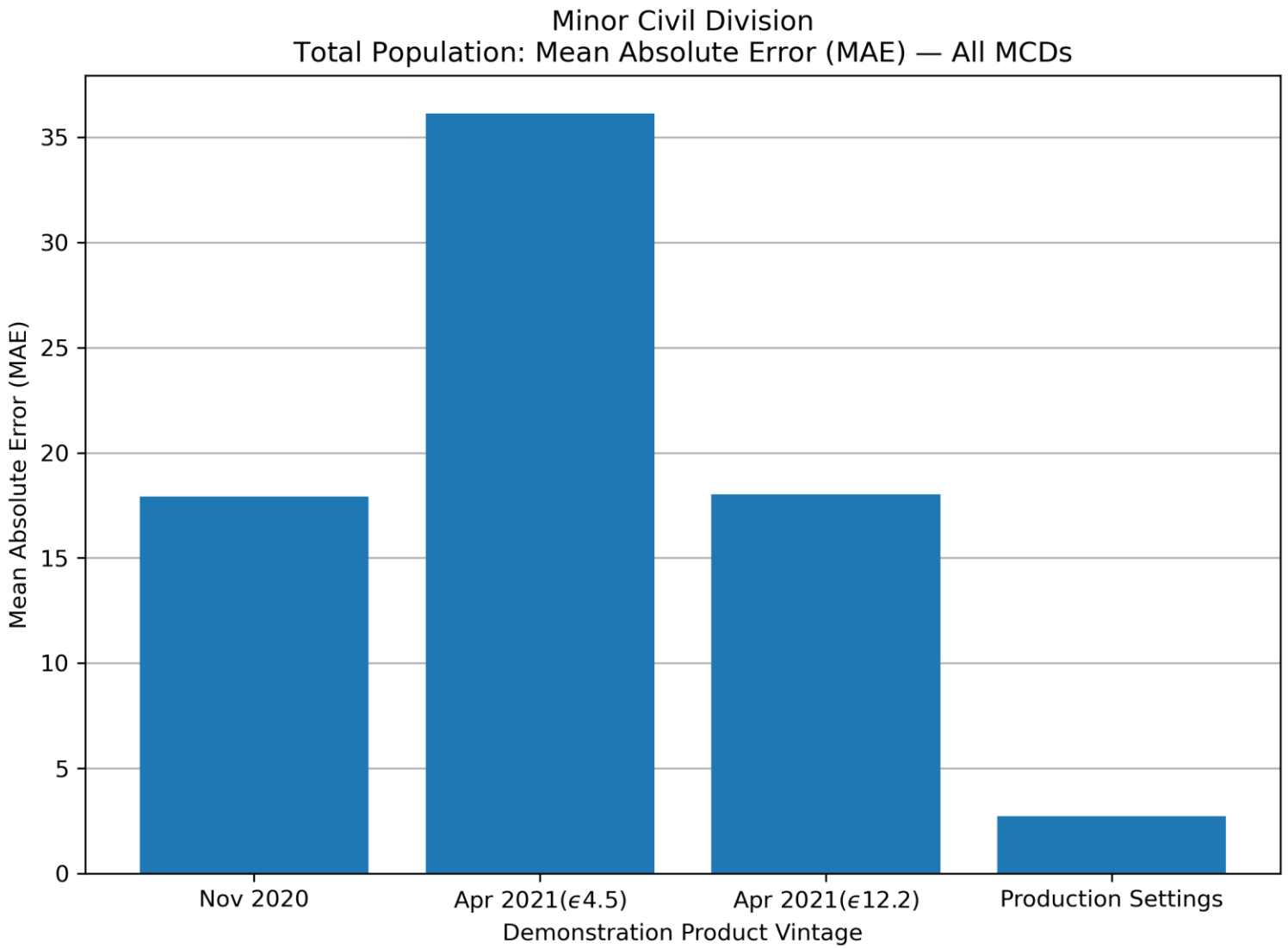
Total Population – Tract



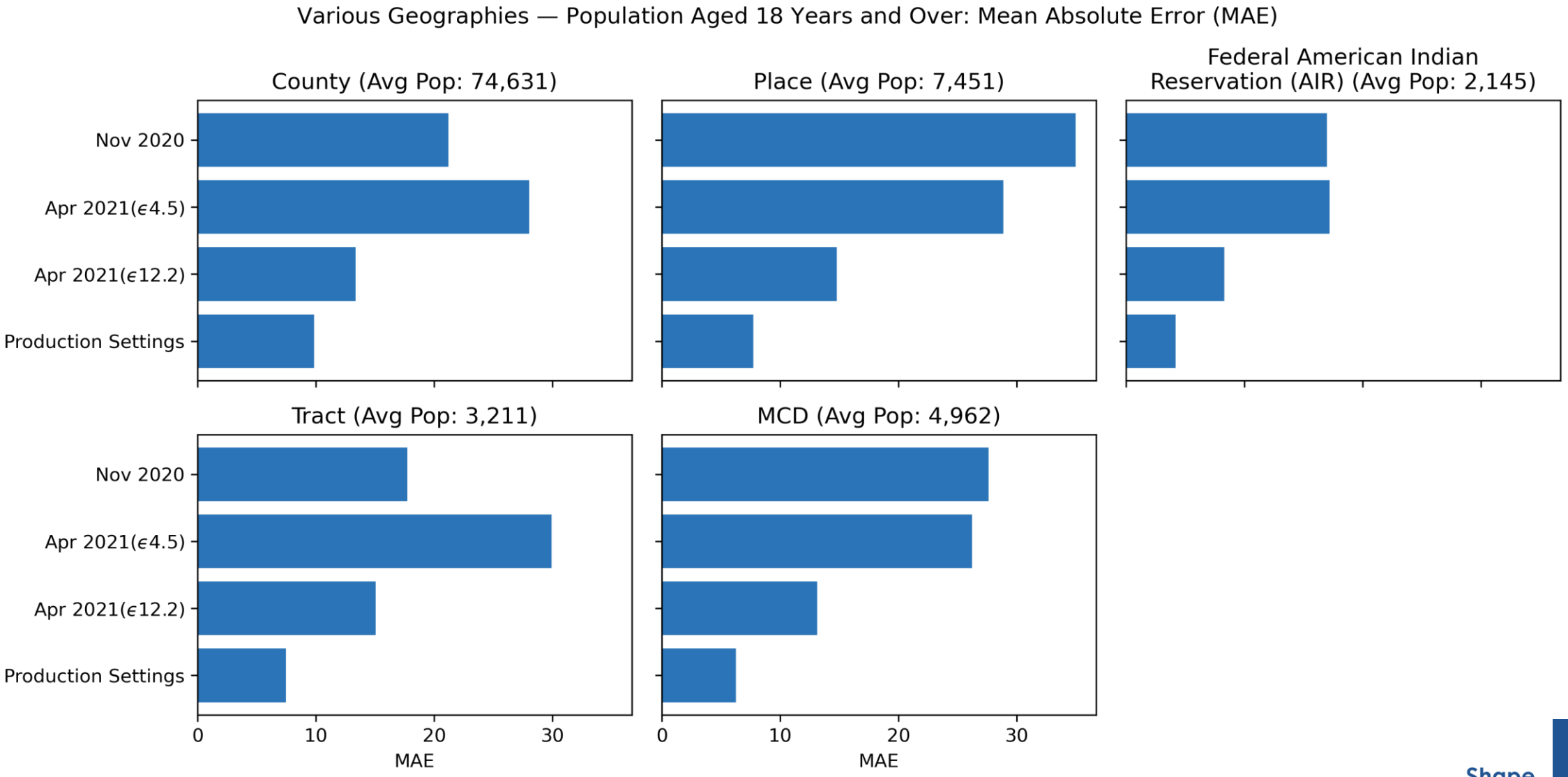
Total Population – Federal American Indian Reservation



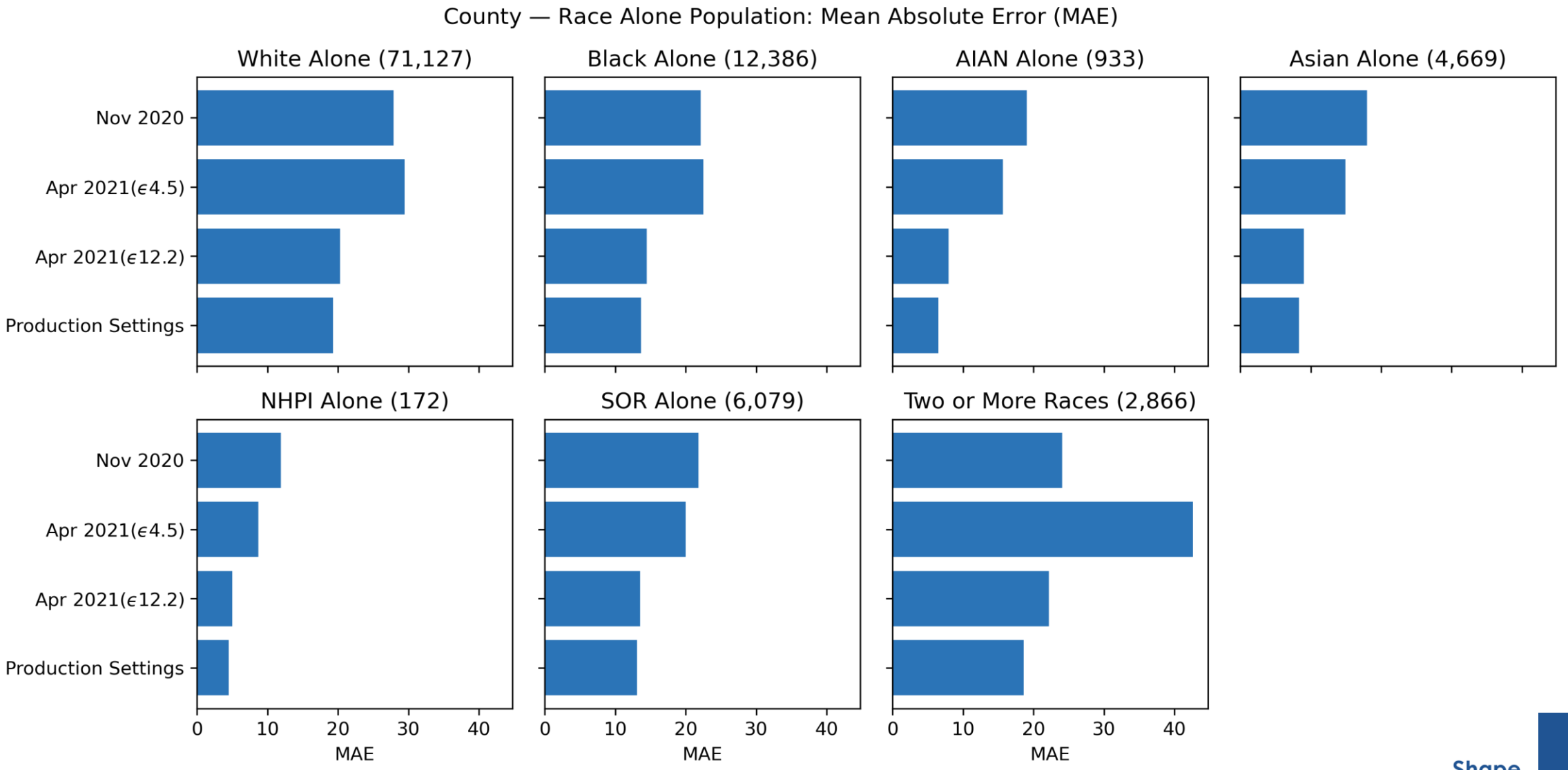
Total Population – Minor Civil Divisions



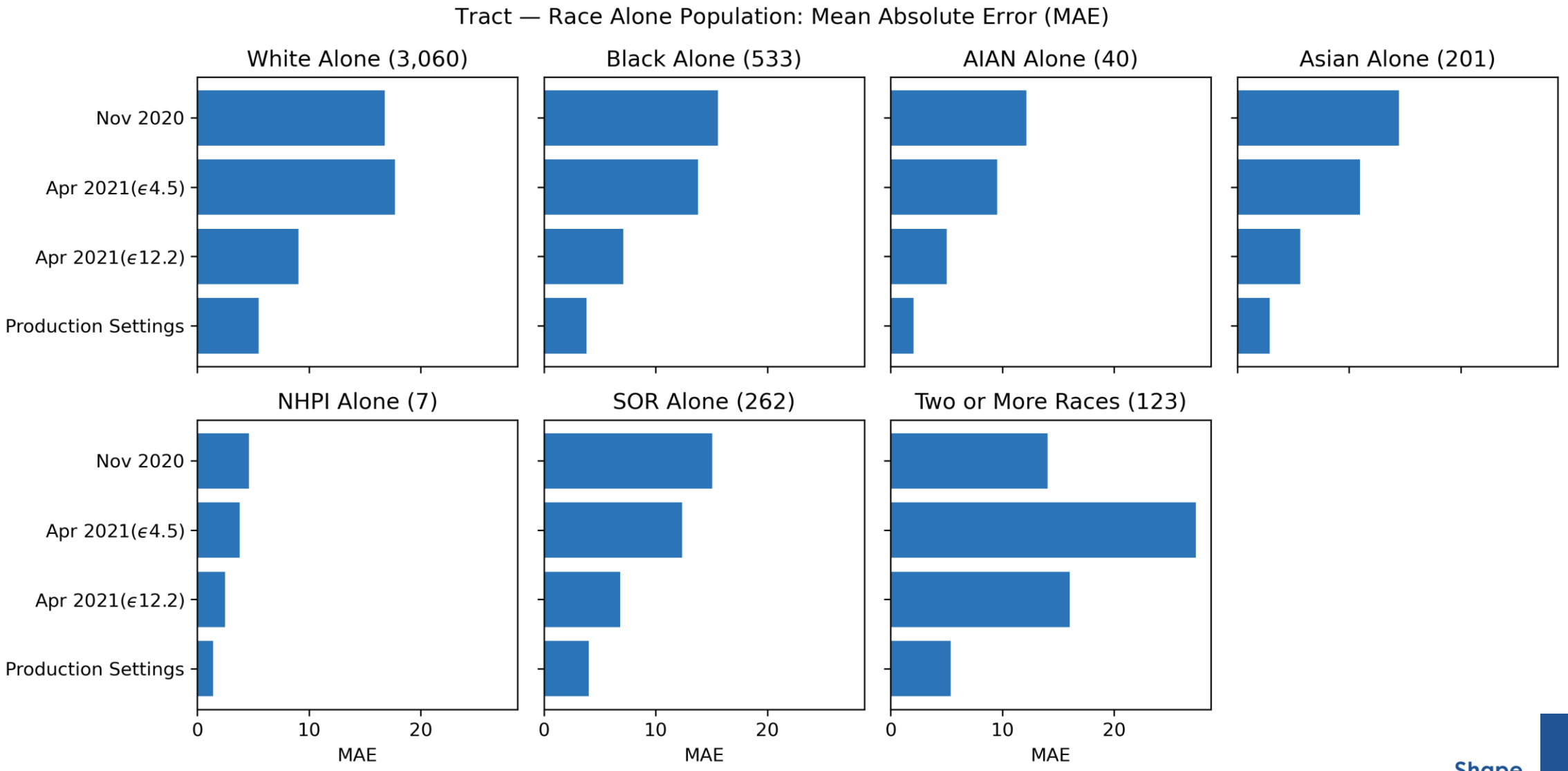
Total Population Aged 18+ – Various Geos.



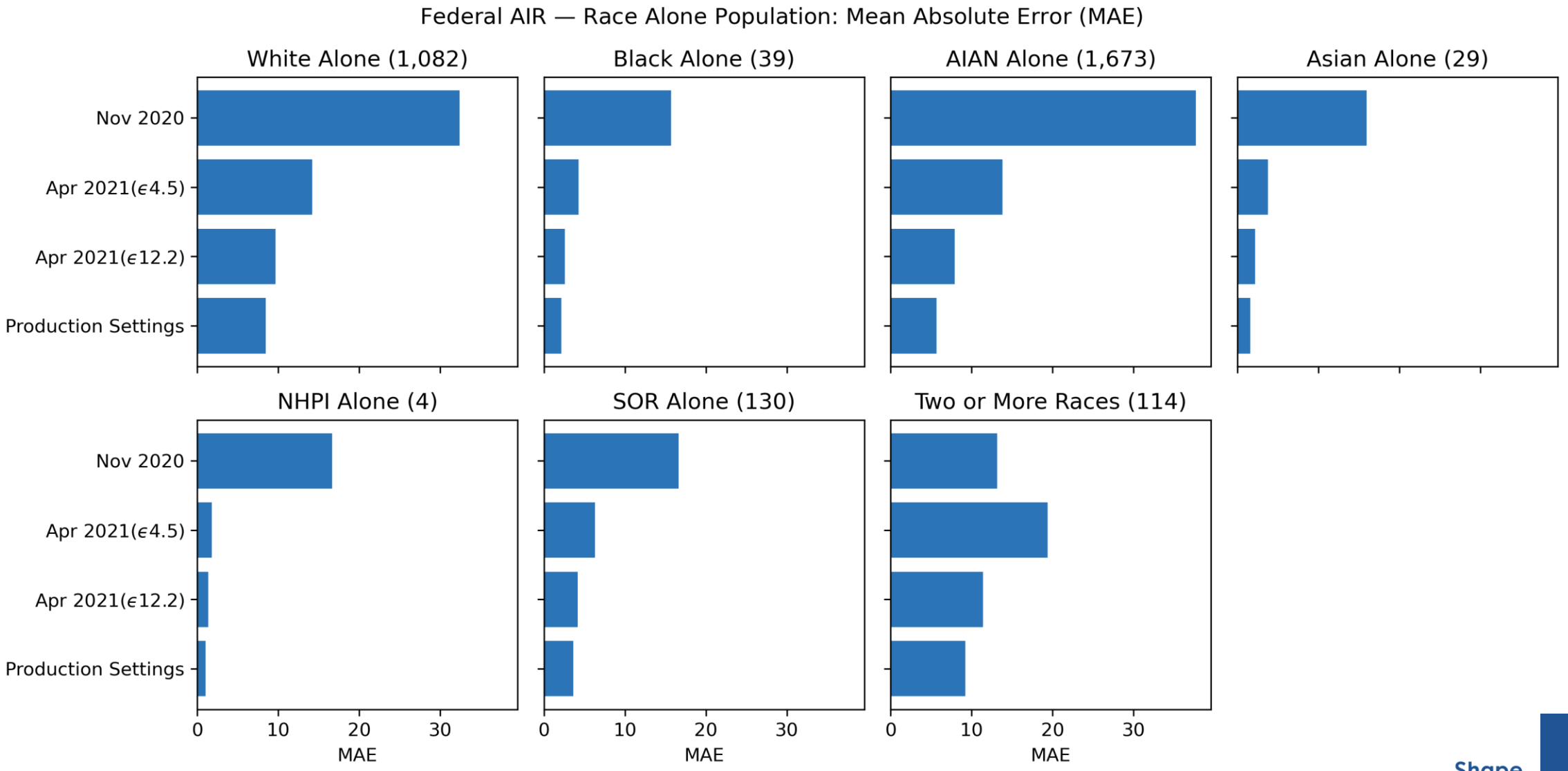
Race Alone – County



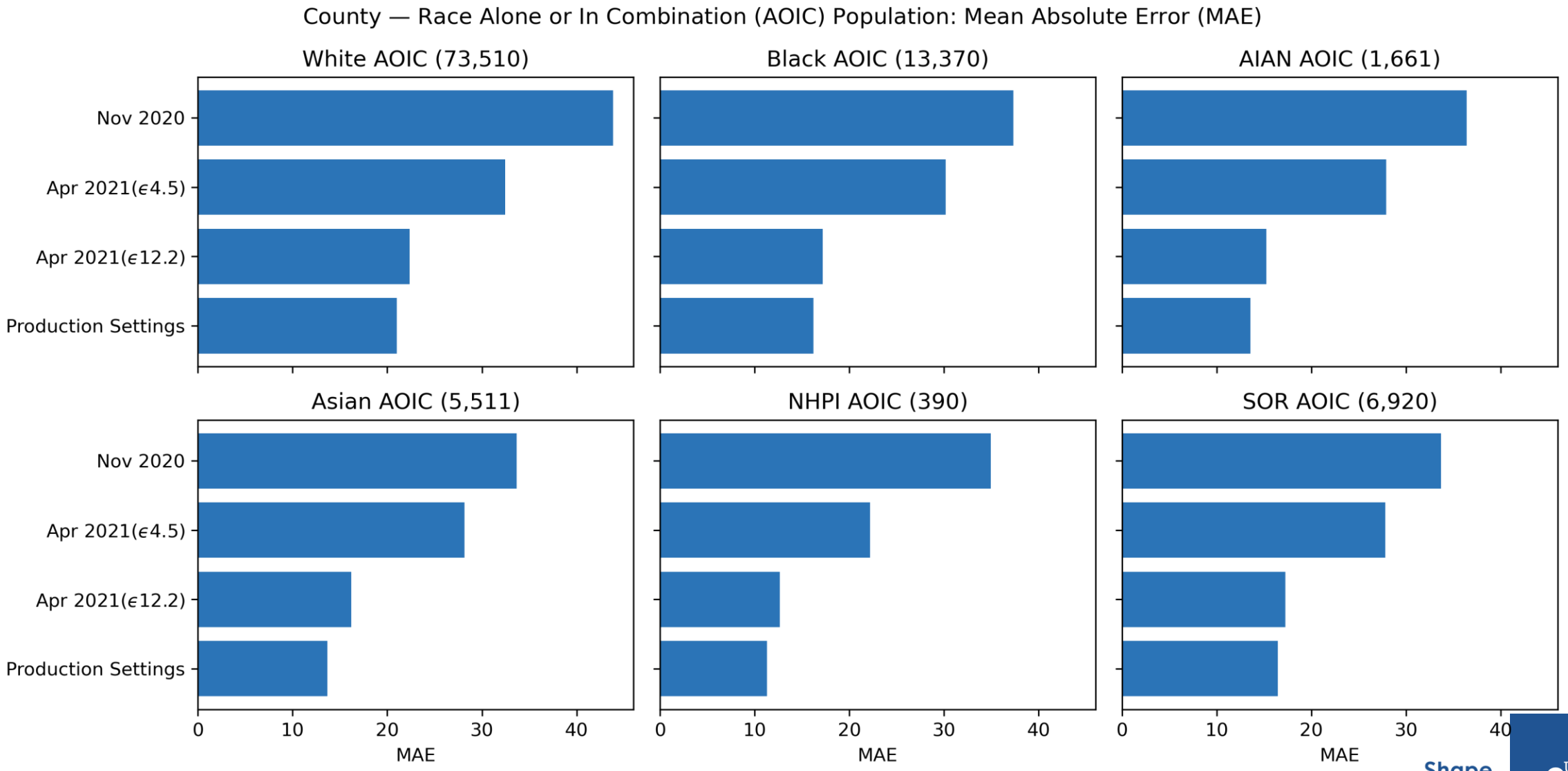
Race Alone – Tract



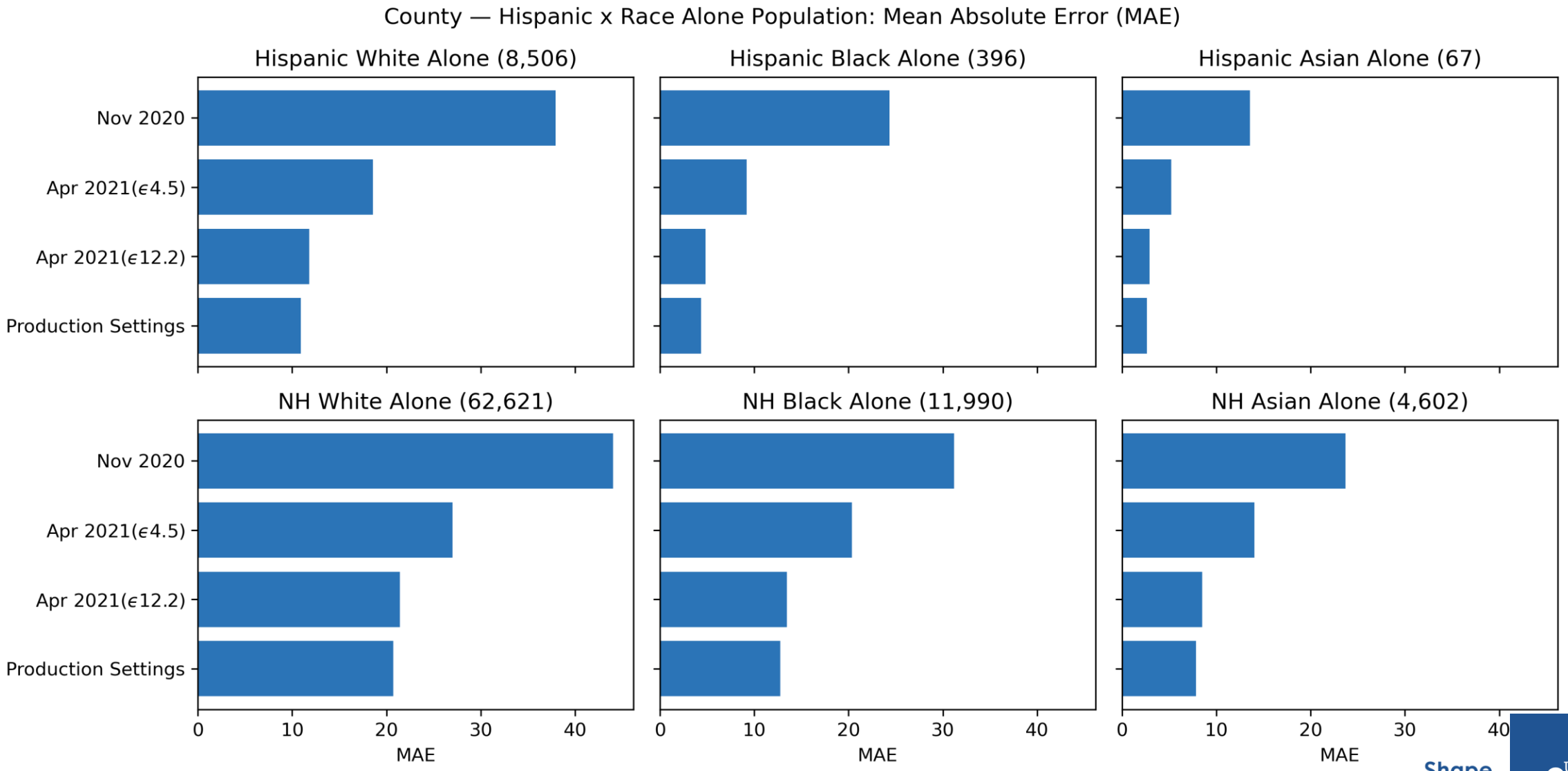
Race Alone – Federal AIR



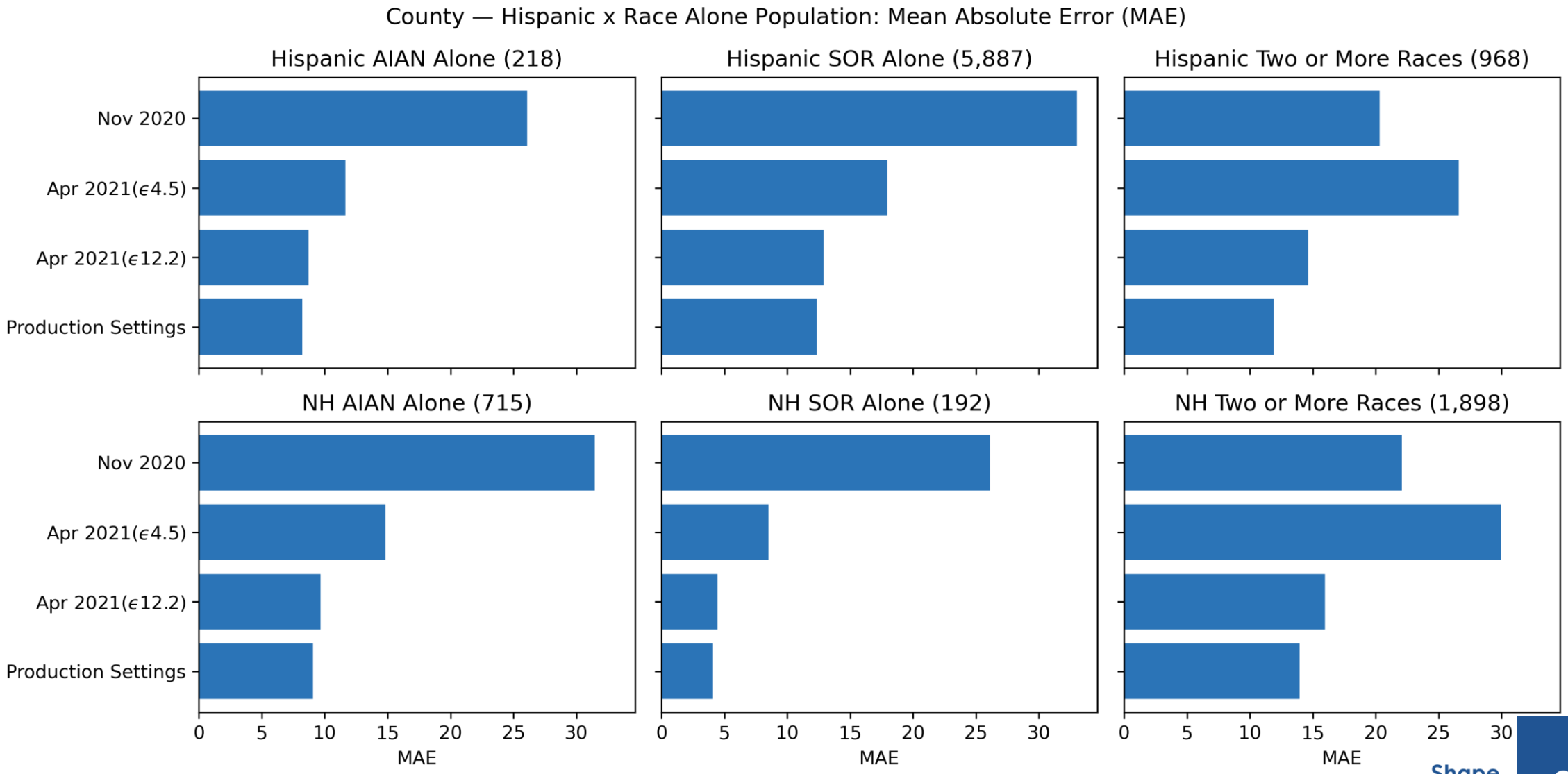
Race Alone or in Combination – County



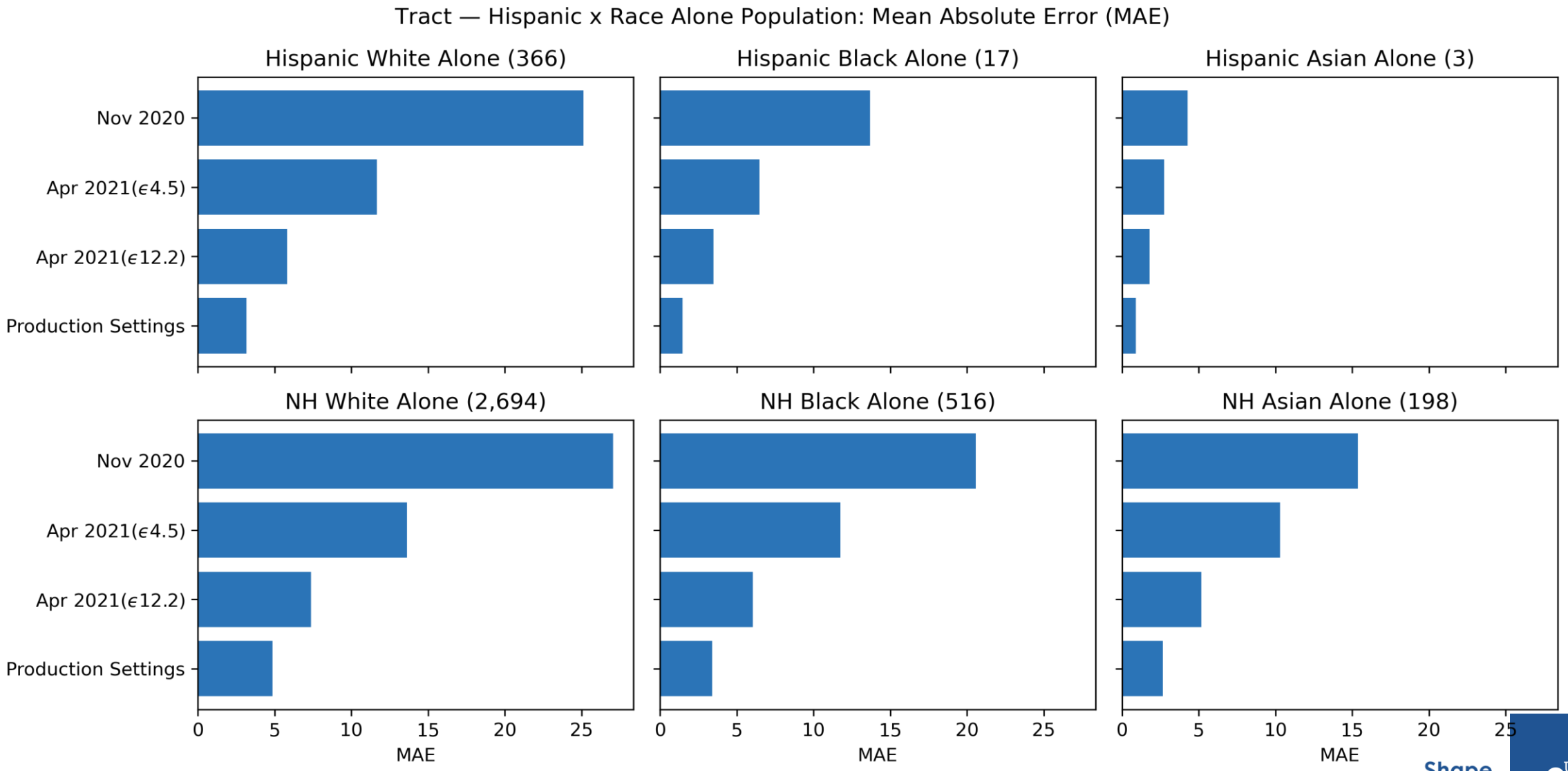
Hispanic x Selected Race Alone – County



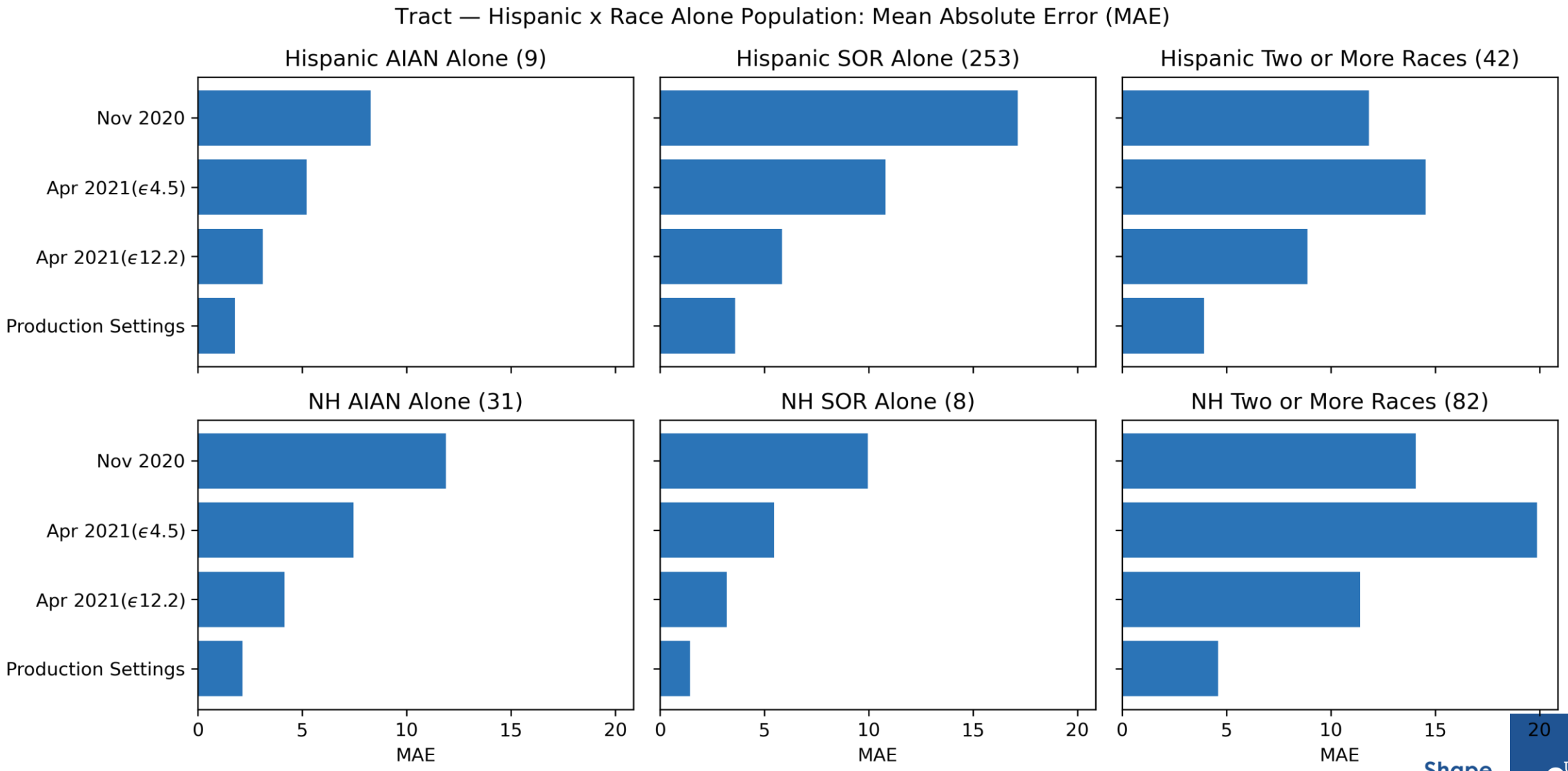
Hispanic x Selected Race Alone – County



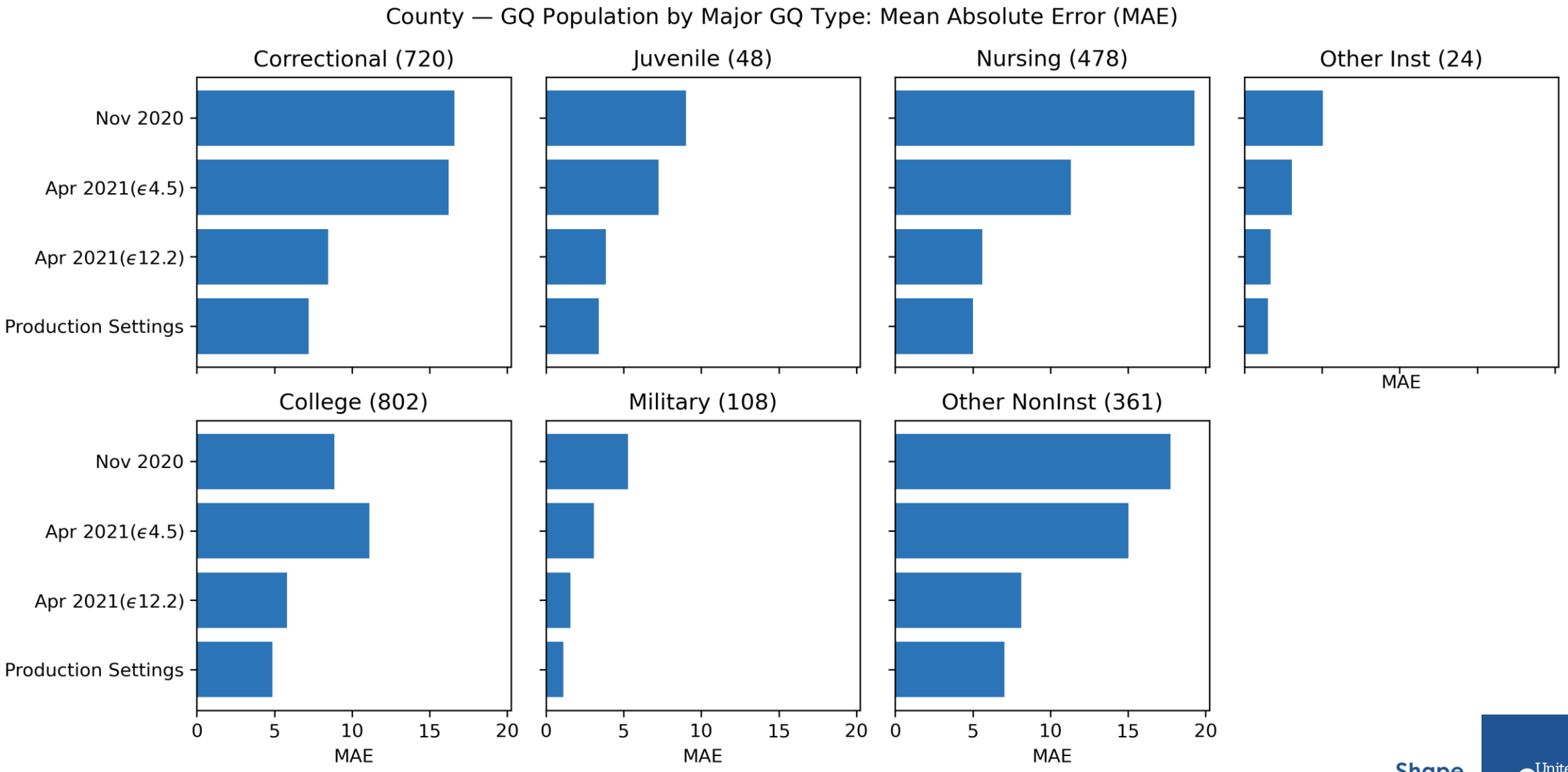
Hispanic x Selected Race Alone – Tract



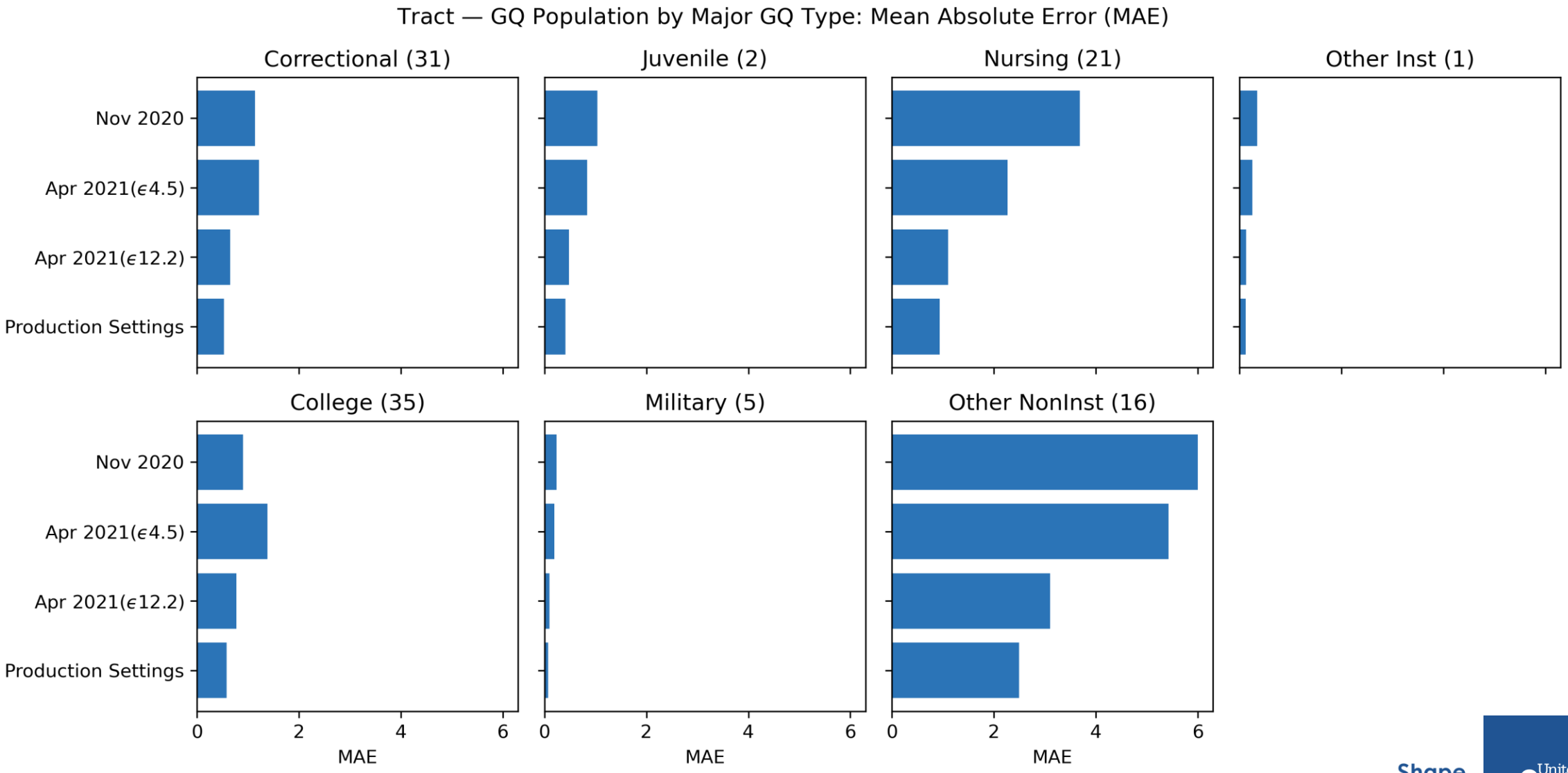
Hispanic x Selected Race Alone – Tract



GQ Major Type – County



GQ Major Type – Tract



Addressing Bias

April 2021 PPMF

Block Groups

Diversity Quintile	Mean Difference In Total Population
0 – Least Diverse	5.04
1	4.24
2	0.99
3	-2.21
4 – Most Diverse	-8.07

Tracts

Diversity Quintile	Mean Difference In Total Population
0 – Least Diverse	15.95
1	11.15
2	3.01
3	-6.17
4 – Most Diverse	-23.94

Production Settings

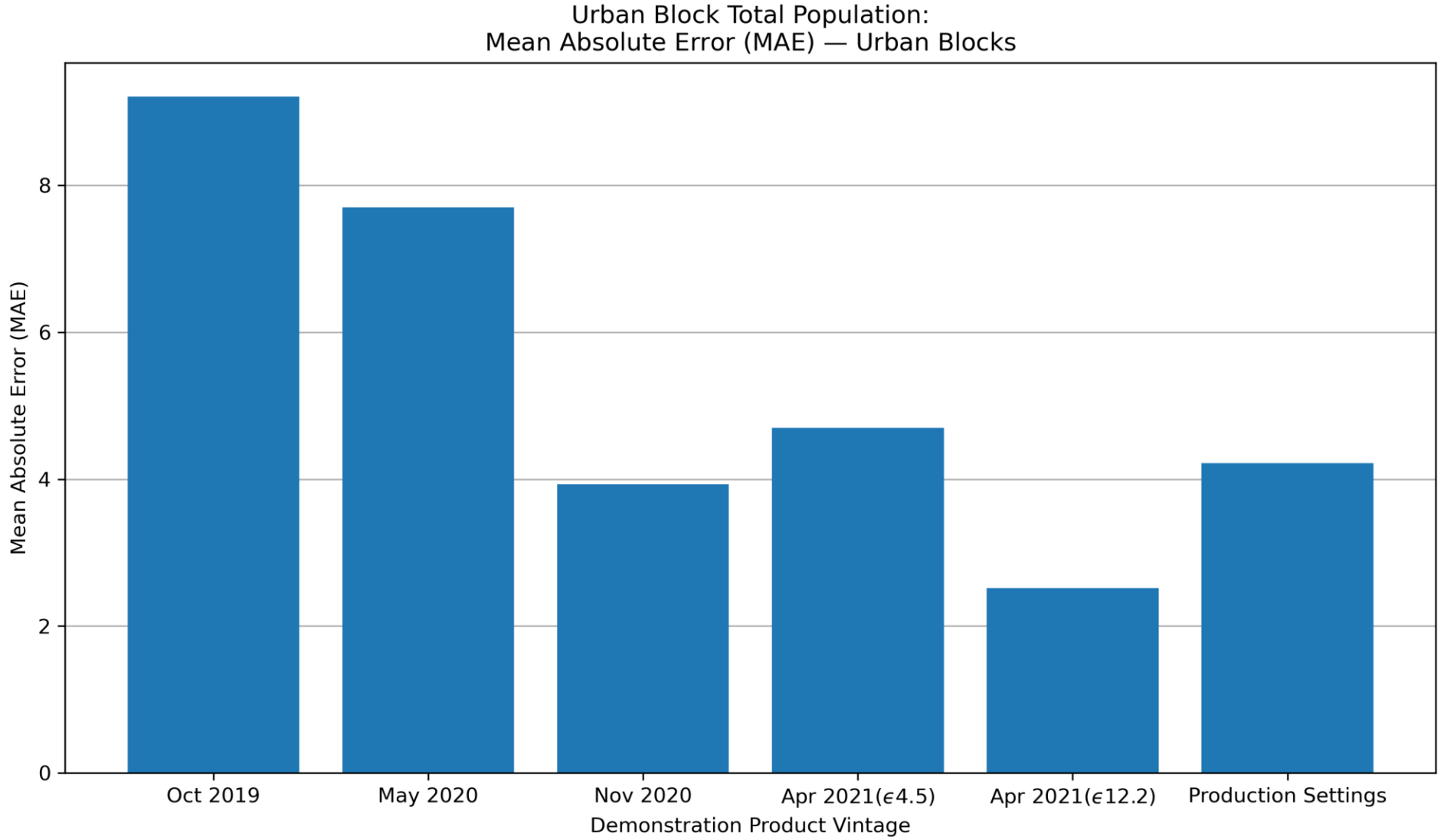
Block Groups

Diversity Quintile	Mean Difference In Total Population
0 – Least Diverse	-0.375
1	1.009
2	0.997
3	-0.303
4 – Most Diverse	-1.352

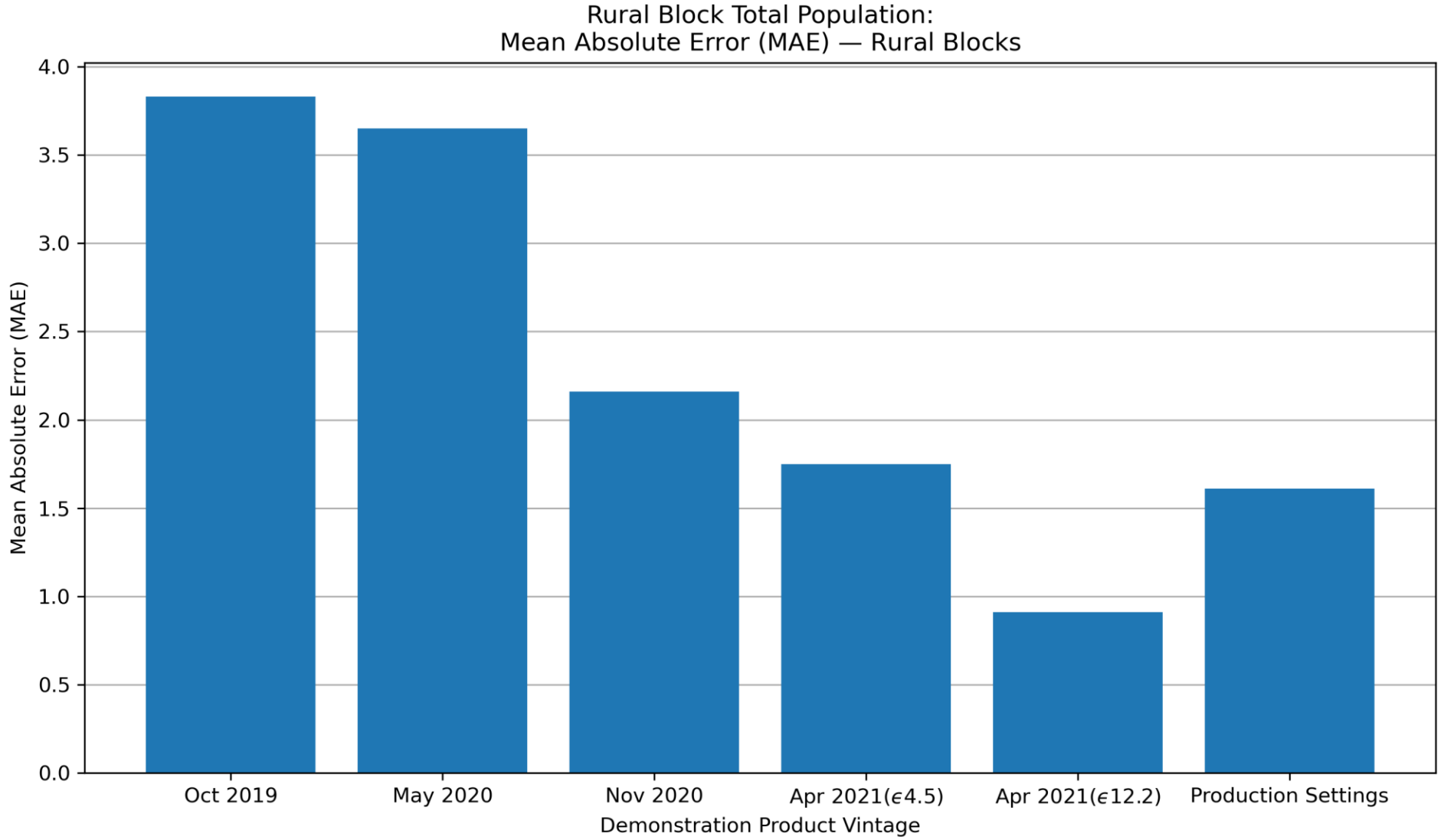
Tracts

Diversity Quintile	Mean Difference In Total Population
0 – Least Diverse	0.029
1	0.045
2	0.000
3	-0.020
4 – Most Diverse	-0.053

Total Population – Urban Block



Total Population – Rural Block



Block-Level Inconsistencies

Inconsistency	April 2021 ε12.2 Count of Blocks	Production Settings Count of Blocks
Occupied Housing Units > Household Population	203,519	303,984
Zero Occupied Housing Units; >0 Household Population	674,598	505,840
Zero Household Population; >0 Occupied Housing Units	77,947	148,836
Everyone in Block Under 18	90,534	163,884
> 10 Persons Per Household	87,342	121,376

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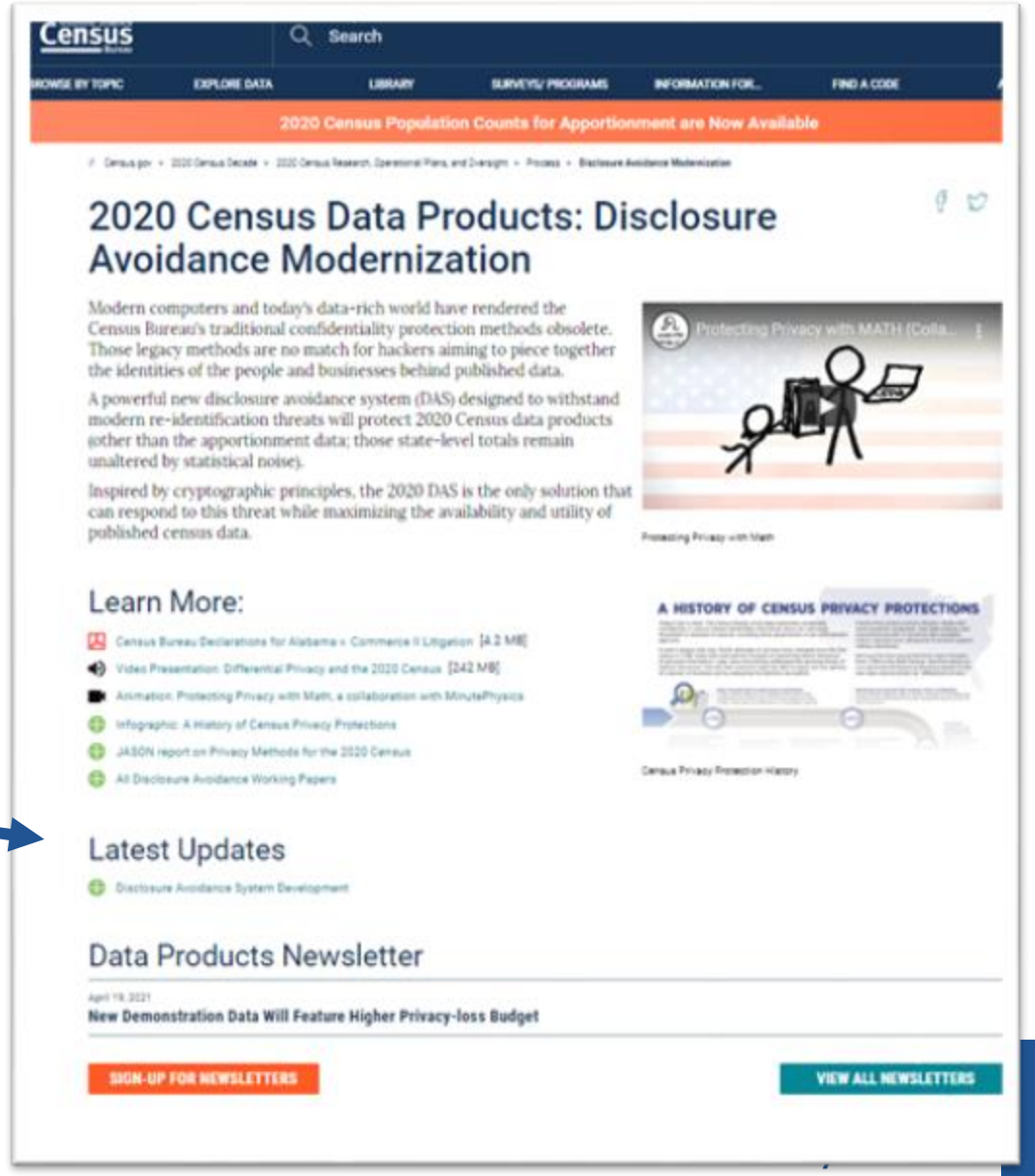

United States Census 2020

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Questions?